Ministry
of
Transportation
Ontario

MI-118

# AN EVALUATION OF A RUBBER-COATED STEEL DRUM VIBRATORY ROLLER NUMBER 2

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

# AN EVALUATION OF A RUBBER-COATED STEEL DRUM VIBRATORY ROLLER NUMBER 2

BY

R.C. EVERS

AND

D.F. LYNCH

BITUMINOUS SECTION

ENGINEERING MATERIALS OFFICE

APRIL 1988

ISBN 0-7729-4267-6

## ABSTRACT

Over a period of two construction seasons, 1986 and 1987, the Ontario Ministry Of Transportation evaluated a rubber coated steel drum vibratory roller for use in compacting hot mix surface course.

The rubber coating is intended to improve the macro-texture of the pavement surface and thus improve friction values (skid resistance).

The 1986 work is reported in MI-104.

This report covers the 1987 construction and the test data for both 1986 and 1987 work. Data on compaction, permeability and friction values are presented.

It is concluded that the rubber coated steel drum vibratory roller can:

achieve equivalent compaction to a normal rolling train provided time is taken to determine the optimum rolling pattern,

be expected to produce a less permeable mat except on 55% stone DFC mixes,

achieve equal or slightly lower friction values than normal compaction equipment.

INDEX


| | Page No. |
|---|---|
| INTRODUCTION | 1 |
| LOCATION | 2 |
| CONSTRUCTION (1987) | 3 |
| TEST RESULTS | 4 |
| DISCUSSION | 10 |
| CONCLUSIONS | 10 |
| REFERENCE | 11 |

## 1. INTRODUCTION

Dynapac Ltd., a manufacturer of vibratory rollers, modified a CC-42A dual drum asphalt roller by coating the drums with 40 mm of neoprene rubber. The intent of this modification was to increase the macro-texture of the pavement surface, thus increasing skid resistance.

In 1986, the Ministry of Transportation conducted field trials on two contracts to evaluate the performance of the rubber coated drum (RCD) machine relative to the compaction equipment normally used. This work was reported in MI-104 (Jan. 1987). It was found that the RCD machine obtained 1% less compaction on two DFC mixes and equivalent compaction on a HL-1 mix compared to the normal compaction equipment used on the respective contracts. Friction testing on the HL-1 mix indicated that better friction numbers were obtained with the regular compaction equipment. Friction values were not obtained on the two DFC mixes. The work on these trials was limited and considered inconclusive.

In order to gain more experience in 1987 with the use of the RCD machine working under "normal" conditions, the Ministry offered a premium to contractors for its use to compact surface course pavement. The RCD machine was employed on two contracts in Northern Region in 1987.

This report presents observations and data accumulated on the original trials as well as on the two 1987 Northern Region contracts.

## 2. LOCATION

### 2.1 Location of 1987 Contracts

Contract 86-39 is located on Hwy. 35, from 26.3 km south of the junction of Hwy. 117 northerly 13.8 km.

Contract 86-94 consisted of two parts; Hwy. 592 from Hwy. 518 northerly 2.0 km and Hwy. 518 from Hwy. 11 westerly to Sprucedale. See key maps Fig. 1 and 2.

**FIG. 1: CONTRACT 86-39**

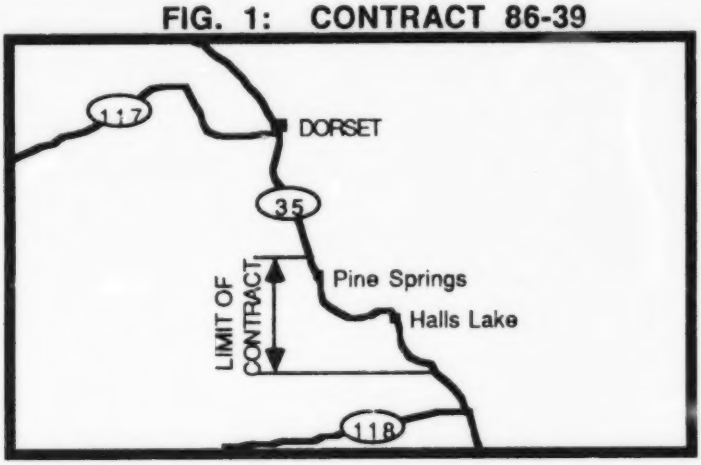
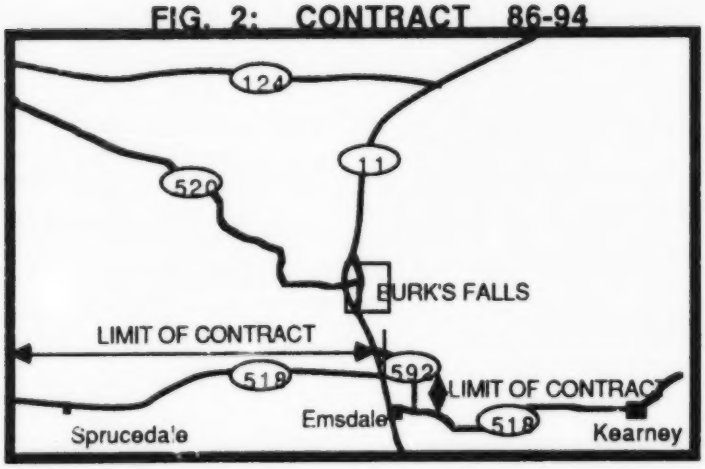



**FIG. 2: CONTRACT 86-94**



## 3. CONSTRUCTION (1987)

### 3.1 Contract 86-39

An HL-4 surface course was placed on this contract with the RCD roller working in the northbound lane behind the lead paver in an echelon paving operation. Compaction behind the second paver consisted of a Dynapac CC-50A vibratory roller followed by a Bros SP-10000, 25 tonne rubber-tired roller.

A review of the first day and a half of surface course paving revealed that the pavement was excessively rough in the lane compacted with the RCD machine. This lane was also extensively hair checked.

The mix was very tender and did not set up as would be expected. After a weekend, three day old material removed to make a transverse joint could easily be broken up by hand.

During the third day of surface course paving, a representative of Dynapac guided the RCD operator in experimenting with various rolling patterns to eliminate the hair checking and improve the rideability. Table 1 summarizes the procedures tried, along with observations.

TABLE 1

| Drums Vibrating | Vibratory Passes | Static Passes | Amplitude | Observations |
|---|---|---|---|---|
| Lead drum | 3 | 1 | High | Extensive hair checking and break-up at edge of drum on last pass. |
| Lead drum | 2 | 1 | High | No hair checking. |
| Both drums | 2 | 0 | High | Hair checking. |
| Both drums | 3 | 0 | Low | Very minor hair checking where overlaps resulted in 4 passes. |

Regardless of the procedure tried, the outside of the mat appeared uncompacted and was easily distorted or damaged by traffic passing within 0.3 m of the unconfined edge. In order to stabilize this edge, the rubber-tire roller working behind the second paver was required to make one pass up the lane compacted with the RCD with the outside tire over the edge of the mat to pinch it in. This procedure appeared to work.

Behind the last pass, the RCD would leave a slight transverse bump (drum bow wave) which would mostly be ironed out by traffic. This bump was most noticeable when the RCD machine was operated in high amplitude.

To avoid confusion for the RCD roller operator as to which mode the roller should be in at any given time, the simplest procedure achieving good visual results was retained. This was three passes with both drums in low amplitude followed by one pass with the rubber-tire roller compacting the edge of pavement.

The surface texture obtained with the RCD machine had more coarse aggregate exposure than that achieved with the standard rolling equipment.

## 3.2 Contract 86-94

Paving on this contract was performed in echelon with the RCD machine working behind the lead paver. The RCD machine was operated without any attempt to determine the optimum rolling procedure. A rubber-tire roller was used to pack in the outside mat edge by making a single pass with the outside tire centered over the mat edge. The second paver was followed by a vibratory breakdown roller and a rubber-tire roller which was also used to pinch in the outside mat edge on the other lane.

Work with the RCD machine was terminated by Ministry staff after completion of the Hwy. 518 portion of the contract and about 30% of Hwy. 518 westerly from Hwy. 11.

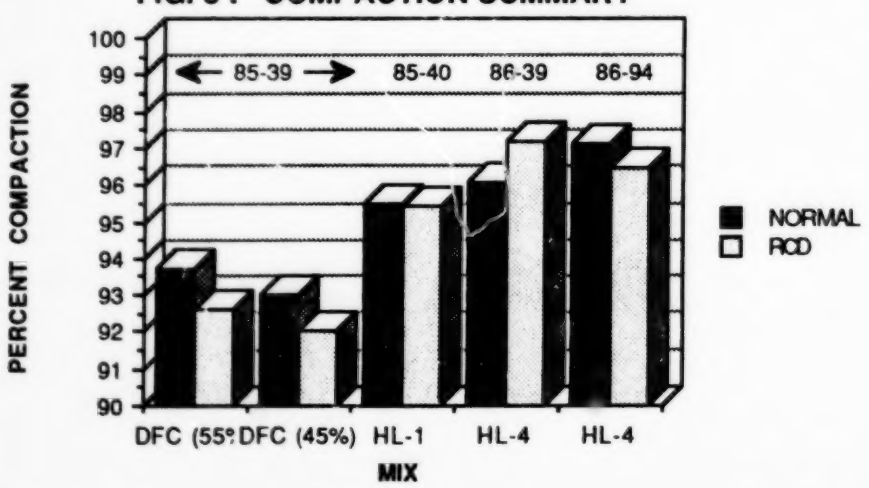
Work with the RCD machine was terminated due to the unsatisfactory finish being obtained. The mat had frequent slight bumps, likely the bow wave behind passes, corrugations throughout and frequent hair checking. The corrugations could easily be seen if the mat was viewed at an acute angle. When driving on the westbound lane compacted with the RCD machine, there was a noisy vibrating ride which was not present in the eastbound lane compacted with standard rollers. In discussions with Regional staff, it was concluded the RCD machine was operated too fast in order to keep up with production. The mat finished with the RCD machine had more coarse aggregate projection than the mat compacted with a standard vibratory roller and rubber-tire roller. The standard rolling produced a tight smooth surface.

## 4. TEST RESULTS

### 4.1 Compaction

Figure 3 summarizers the average main lane compaction achieved on both 1986 and 1987 projects by the RCD machine and normal rollers on the respective contracts. As may be seen, the normal rolling equipment achieved better compaction than the RCD machine on all but one contract. On this contract (86-39), significant time was spent to determine the optimum rolling pattern.

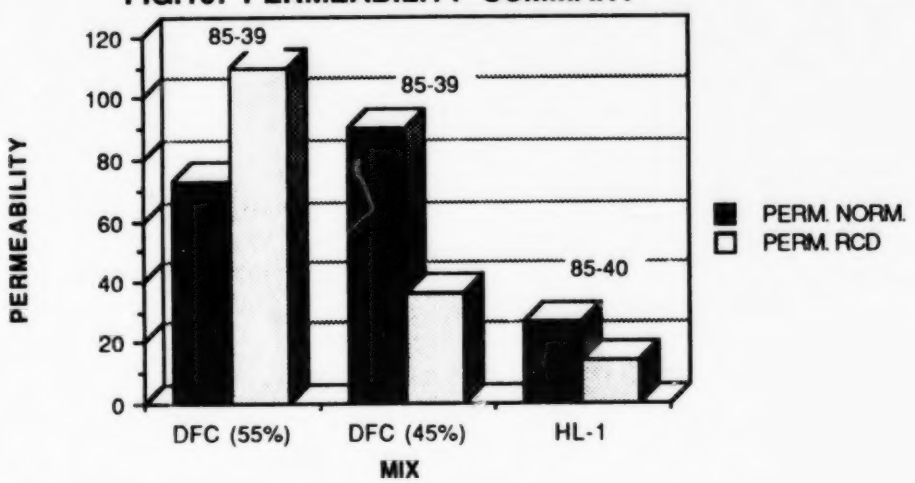
**FIG. 3 : COMPACTION SUMMARY**



## 4.2 Permeability Testing

Permeability testing was conducted in 1987 on the mix placed on the two 1986 contracts. The RCD machine achieved lower permeabilities than the normal rollers with the HL-1 and 45% stone DFC mixes. However, the normal rollers achieved lower permeability on the 55% stone DFC. See Figure 10.

**FIG.10: PERMEABILITY SUMMARY**




## 4.3 Friction Testing

The brake force trailer was used to determine the friction characteristics (SN) of the pavement on each contract. On Contract 85-40, SN determinations were made just after construction (1986) and again the next August (1987). As may be seen in Figs. 4 and 5, the SN values increased with time for both lanes, particularly the left or passing lane. The SN values for Cont. 85-39 (Figs. 6 and 7) were not obtained until the summer after construction. The SN values for the two contracts constructed in 1987 (Figs. 8 and 9) were obtained shortly after construction. As may be seen in these figures, the normal rolling equipment achieved marginally better SN values when compared to the RCD machine on each contract.

FIG. 4: CONTRACT 85-40 ( HL-1 )

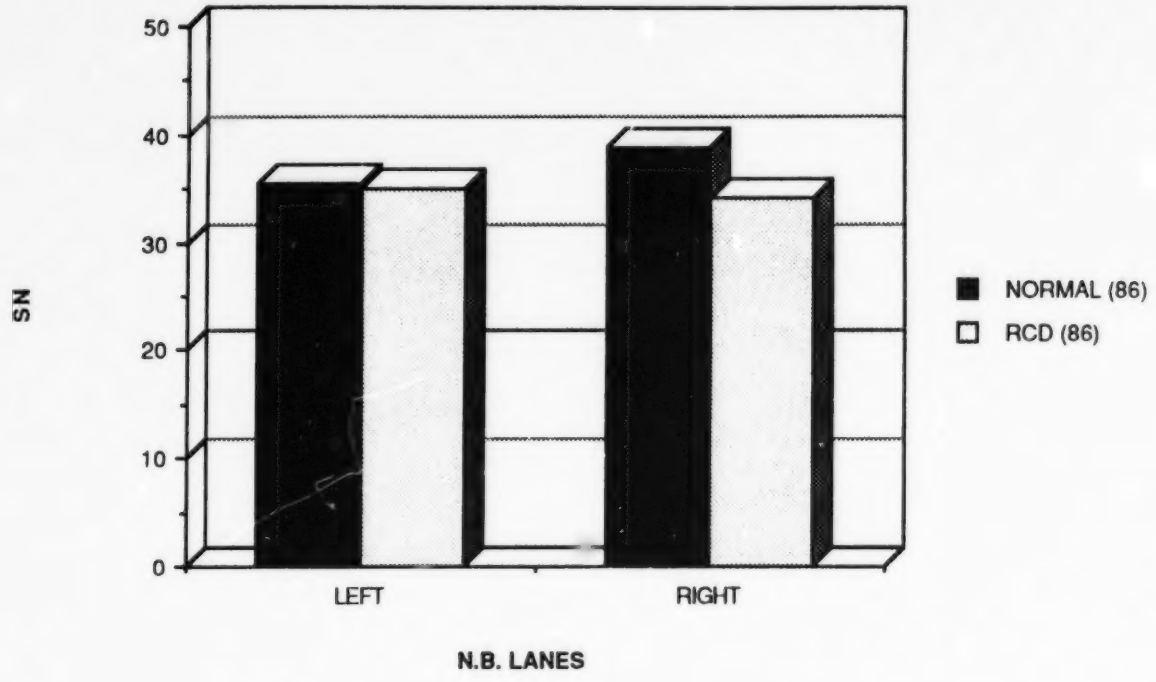



FIG. 5: CONTRACT 85-40 ( HL-1 )

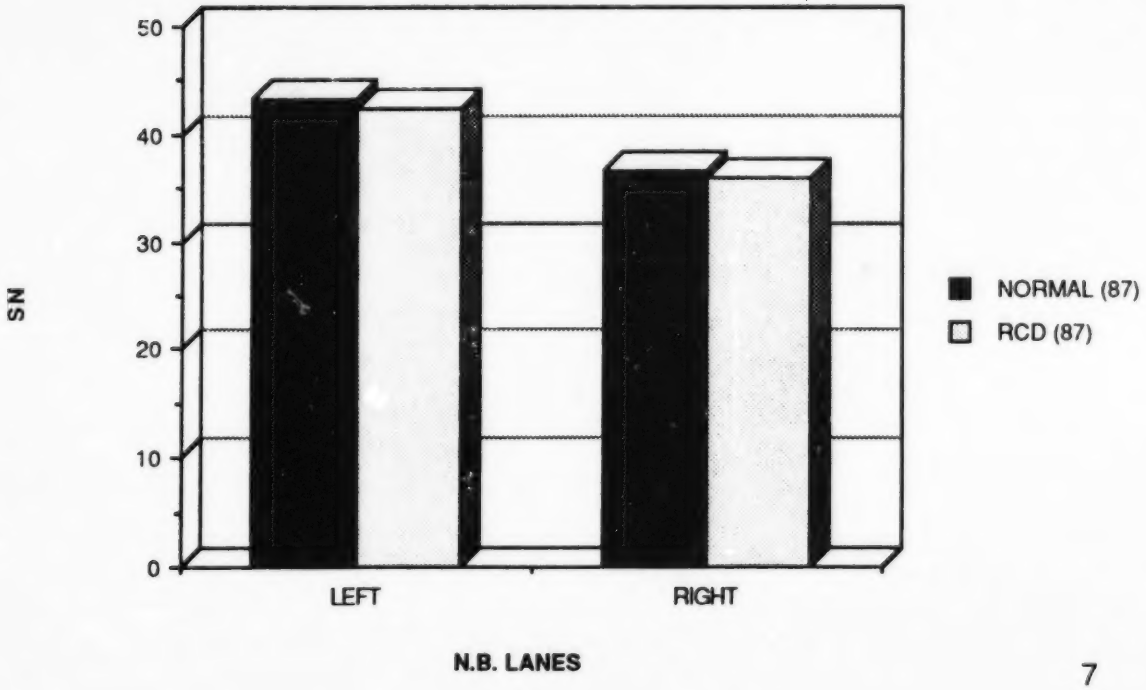


FIG. 6: CONTRACT 85-39 ( DFC 45% ST. )

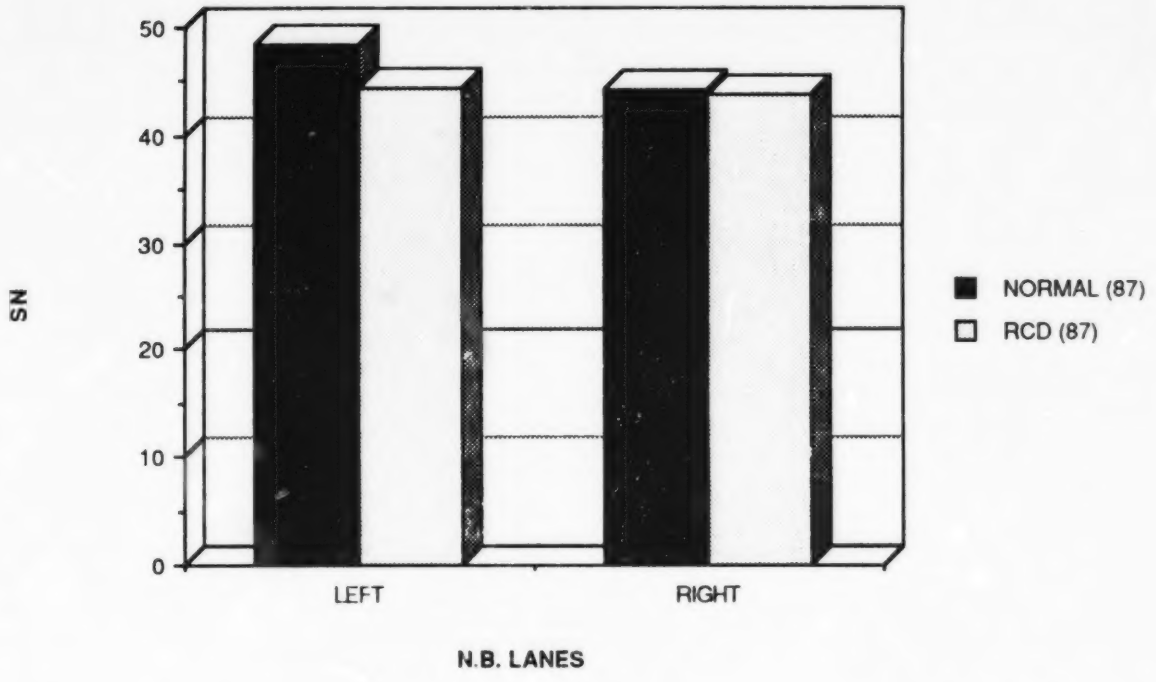



FIG. 7: CONTRACT 85-39 ( DFC 55% ST. )

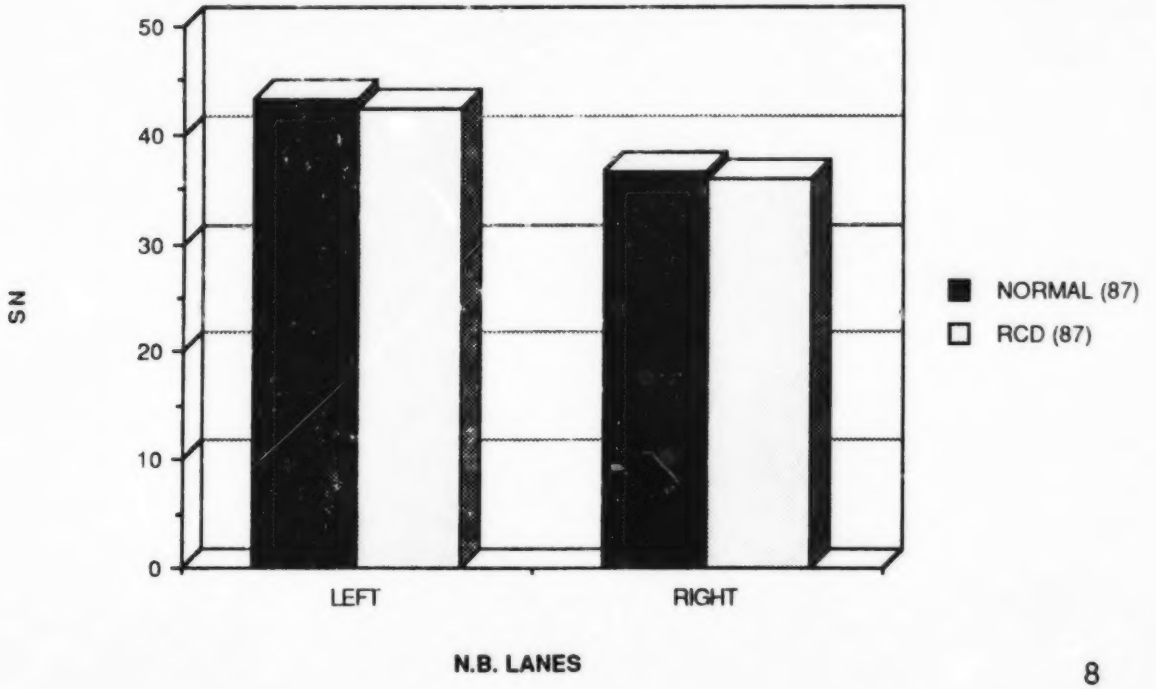


FIG. 8: CONTRACT 86-39 ( HL-4 )

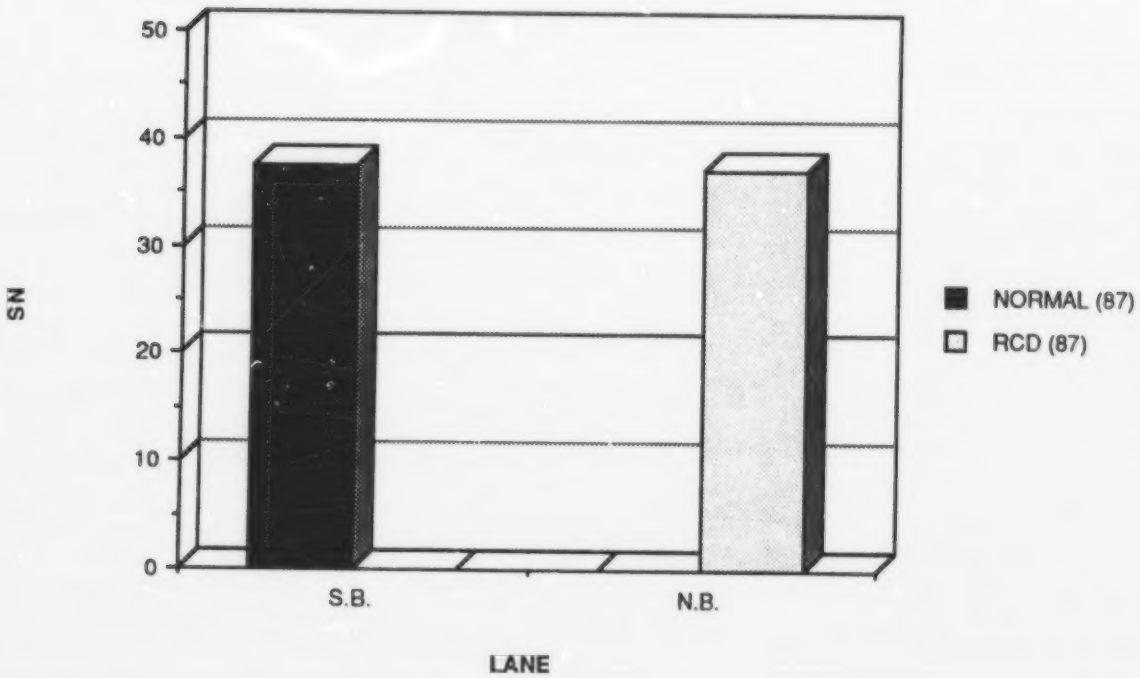
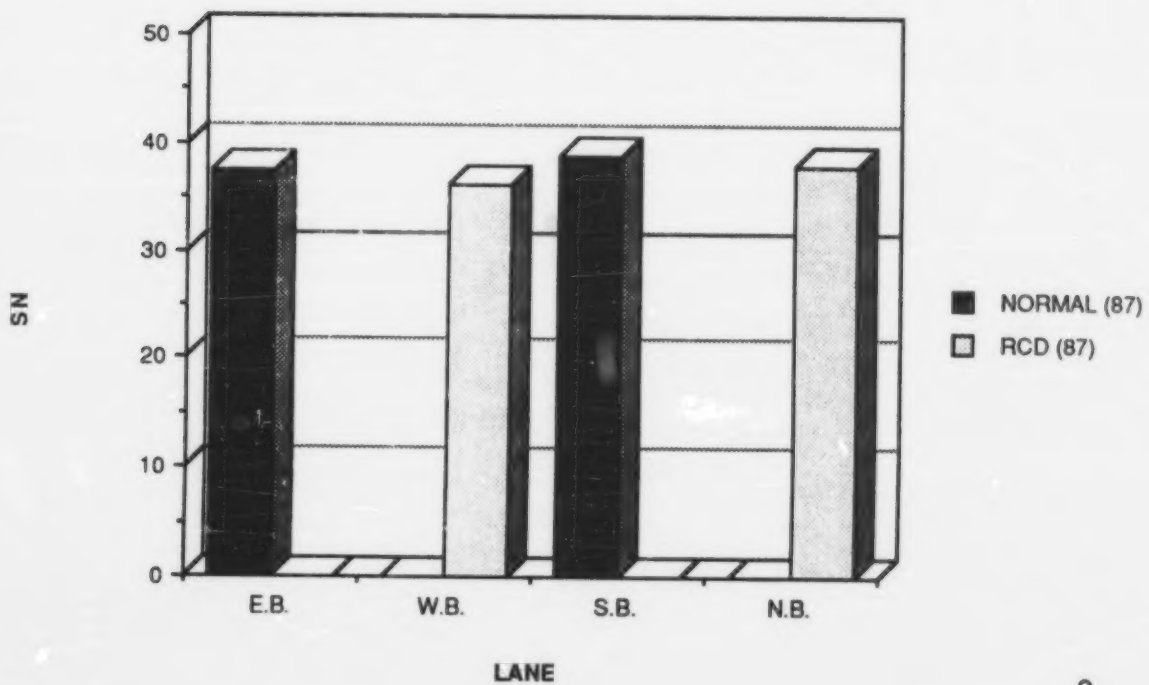



FIG. 9: CONTRACT 86-94 ( HL-4 )



## 5. DISCUSSION

The work to date with the RCD machine indicates that unless the optimum rolling pattern is determined, i.e. number of drums vibrating, amplitude and number of passes, less than satisfactory results may be expected. Hair checking and/or a rough ride and low compaction are possible consequences of not performing this exercise. The RCD machine, on its own, will not satisfactorily compact the outside unconfined edge of a mat. At best, the RCD machine will obtain equivalent or less compaction and friction values compared to normal compaction equipment. Except on the 55% stone DFC mix, the RCD machine compacted a less permeable mat.

The claimed benefit of the RCD machine - namely higher friction numbers compared to normal compaction equipment, has not been demonstrated even though visually it provides more coarse aggregate projection.

## 6. CONCLUSIONS

1. The RCD machine is prone to hair checking if the optimum rolling pattern is not determined.

2. The RCD machine is prone to producing a rough ride on tender mixes or if operated too fast.

3. The RCD machine on its own does not satisfactorily compact the outside unconfined edge of a mat.

4. The RCD machine may be expected to achieve equivalent compaction to regular rolling trains on the main lane paving provided the optimum rolling pattern is determined.

5. The RCD machine will achieve equal or slightly lower friction values than obtained with a normal rolling train.

6. Except for high stone DFC mixes, the RCD machine can be expected to produce a less permeable mat.

## 7. REFERENCE

Bulger, S.A., Korgemagi, P., Lynch, D,F., "An Evaluation Of A Rubber-Coated Steel Drum Vibratory Roller", MI-104, Ontario Ministry Of Transportation And Communications, January 1987.